

National Aeronautics and Space Administration

Oak Ridge Associated Universities



NASA Earth Science Division Applied Sciences Program

NASA Postdoctoral Program SERVIR

Fellow: Max J. Moreno Madriñán

Authors: Max J. Moreno Madriñán
Africa Flores Cordova
Francisco Delgado Olivares
Dan Irwin



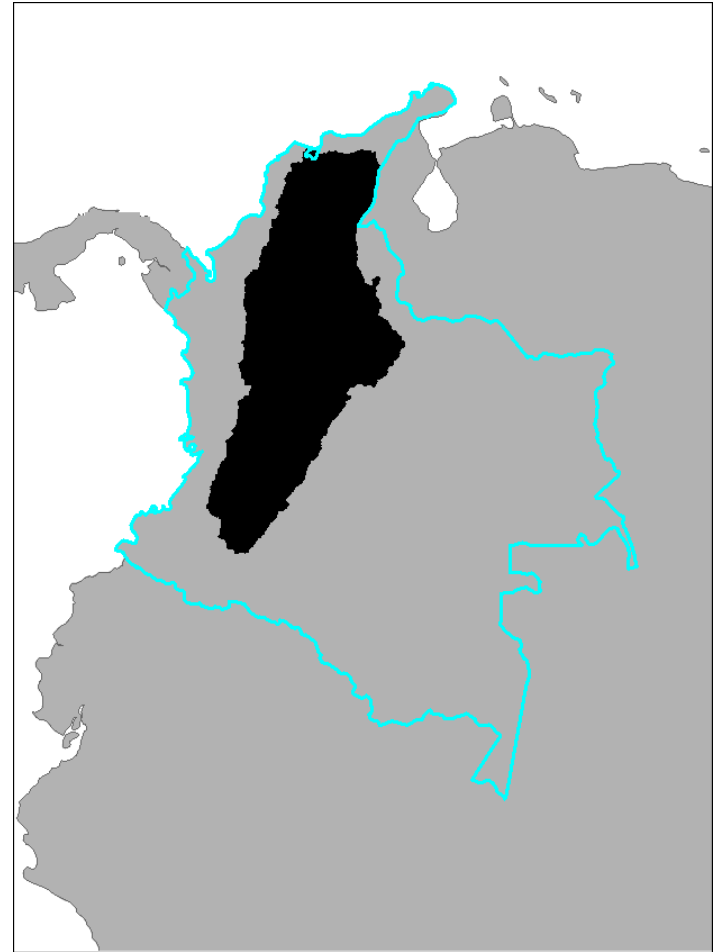
***Relationship between Change in Land Cover in the
Magdalena River Watershed and Water Reflectance at the
Points of Discharge***

Fortaleza 08-13-2012

Outline

- Location
- Reflectance - MOD09GQ (as inference of turbidity)
 - Change
 - Time series
- Digital Elevation Model -The Shuttle Radar Topography Mission (SRTM)
- Land Cover (LC)- MCD12Q1
 - Change
 - Time series
- Relationship between LC and coastal water reflectance

Location on South America



Reflectance (turbidity?)

Study period: 2001-2011

Satellite: Terra

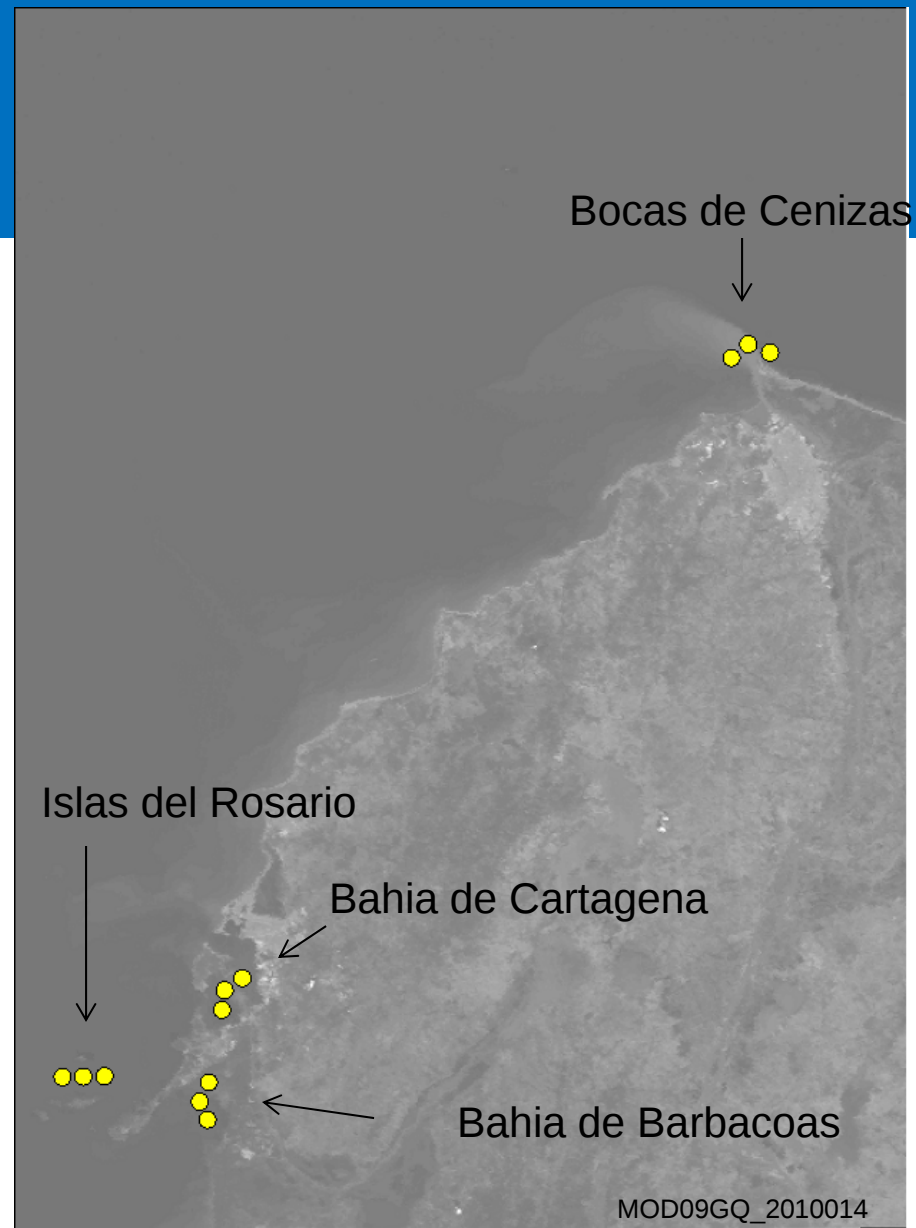
Sensor: MODIS

Product: MOD09GQ

Spatial Resolution: 250 m

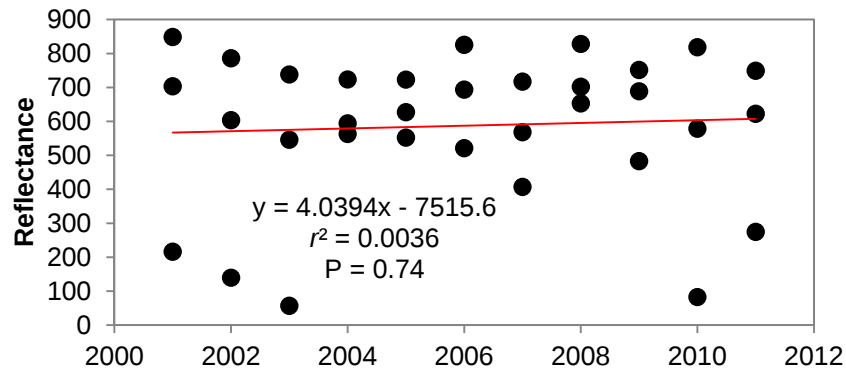
Temporal Resolution: Daily

Sites	Latitude - Longitude
Bocas de Cenizas	11.134000 -74.857000
	11.117000 -74.879000
	11.123000 -74.829000
Bahía de Cartagena	10.334000 -75.528000
	10.319000 -75.551000
	10.294000 -75.555000
Islas del Rosario	10.211123 -75.735903
	10.211123 -75.708500
	10.211123 -75.763100
Bahía de Barbacoas	10.201000 -75.573500
	10.176500 -75.585700
	10.153000 -75.576000

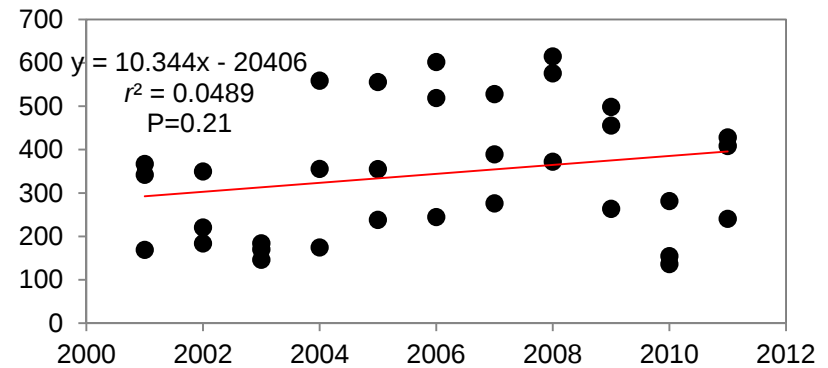


Time series: Median reflectance between January to March (driest months) per year (2001-2011)

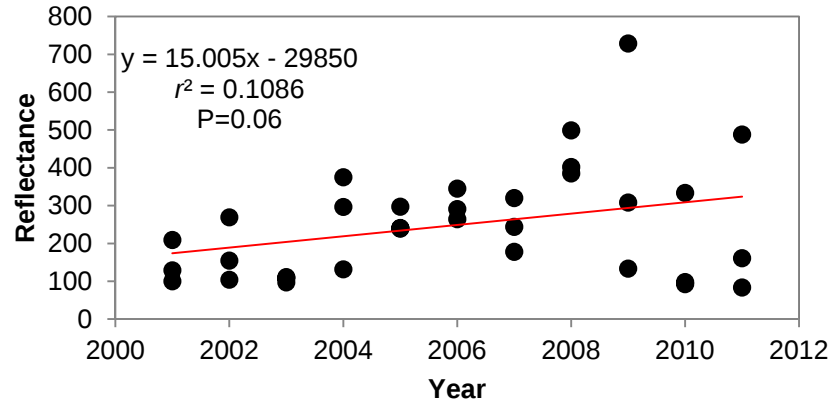
Bocas de Ceniza



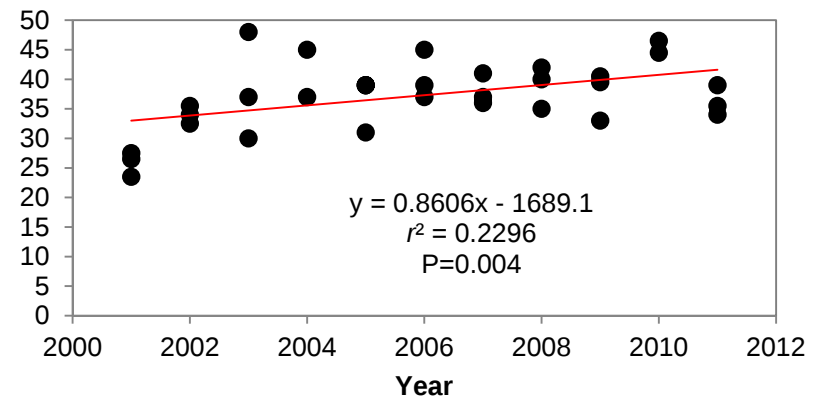
Bahía de Cartagena



Bahía de Barbacoas



Islas del Rosario



Digital Elevation Model

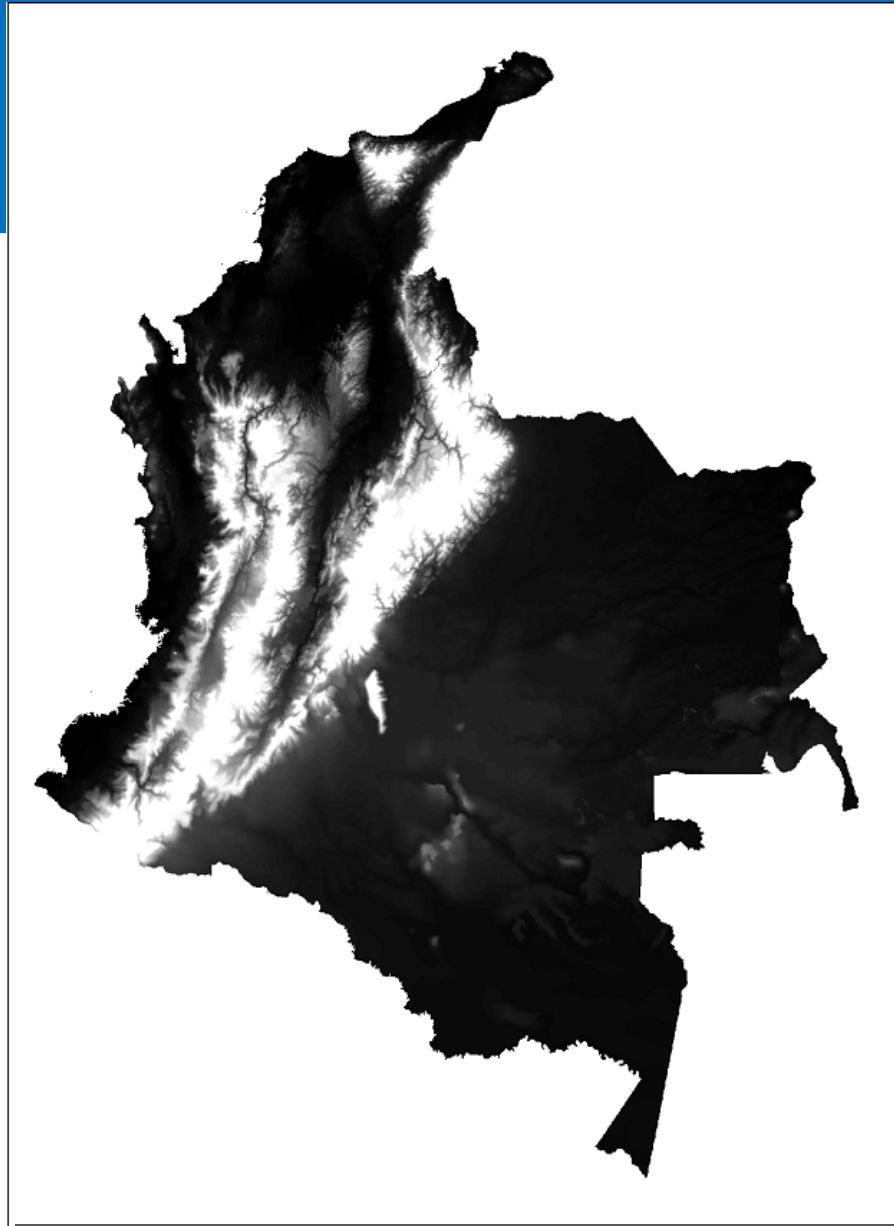
The Shuttle Radar Topography Mission (SRTM)

Year: **2000**

Space Shuttle Endeavour

Spatial Resolution: 90 m

Temporal Resolution: one 11-day mission in February of 2000



Land Cover

Rio Magdalena Watershed

Year: 2001

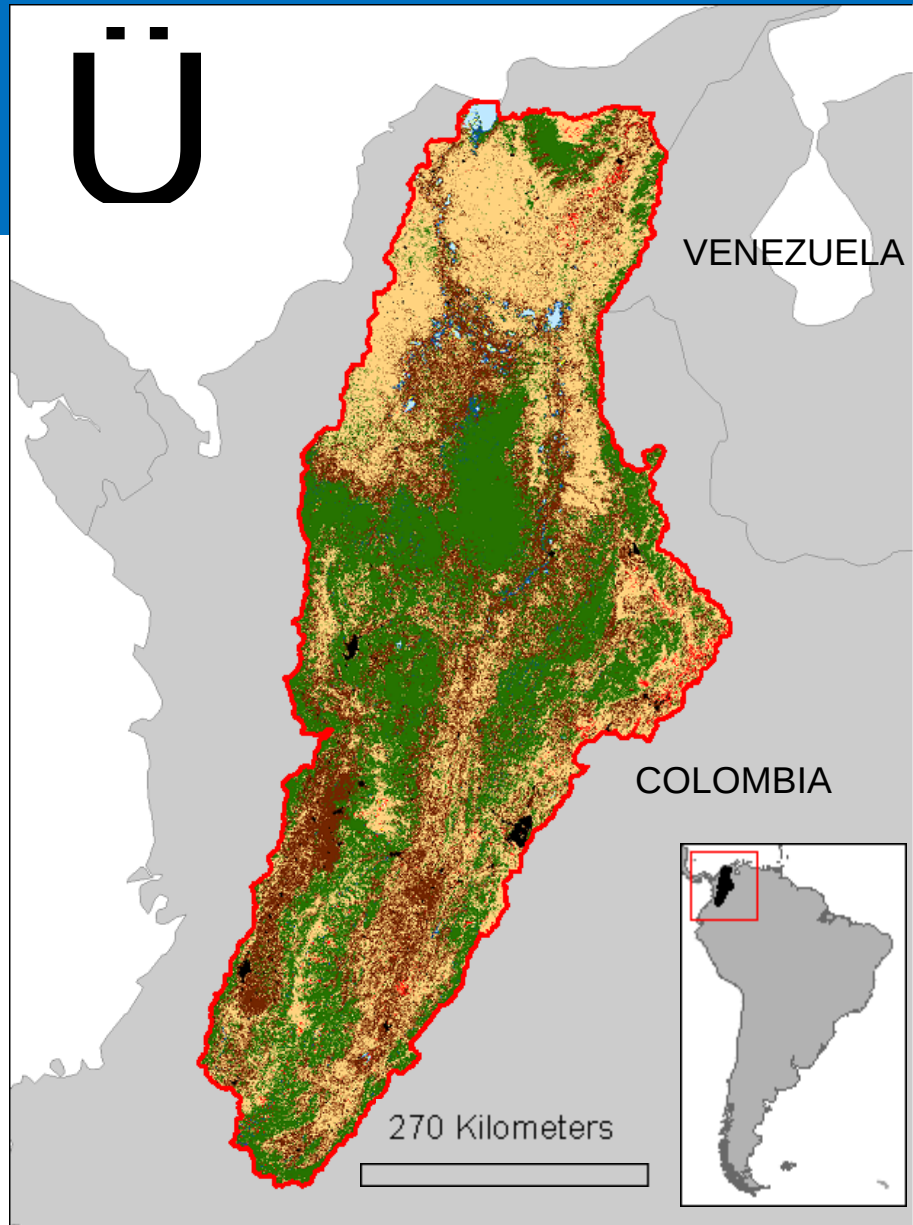
Satellite: Aqua and Terra

Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer)

Product: MCD12Q1

Spatial Resolution: 1 km

Temporal Resolution: annual



Land Cover

Rio Magdalena Watershed

Year: 2002

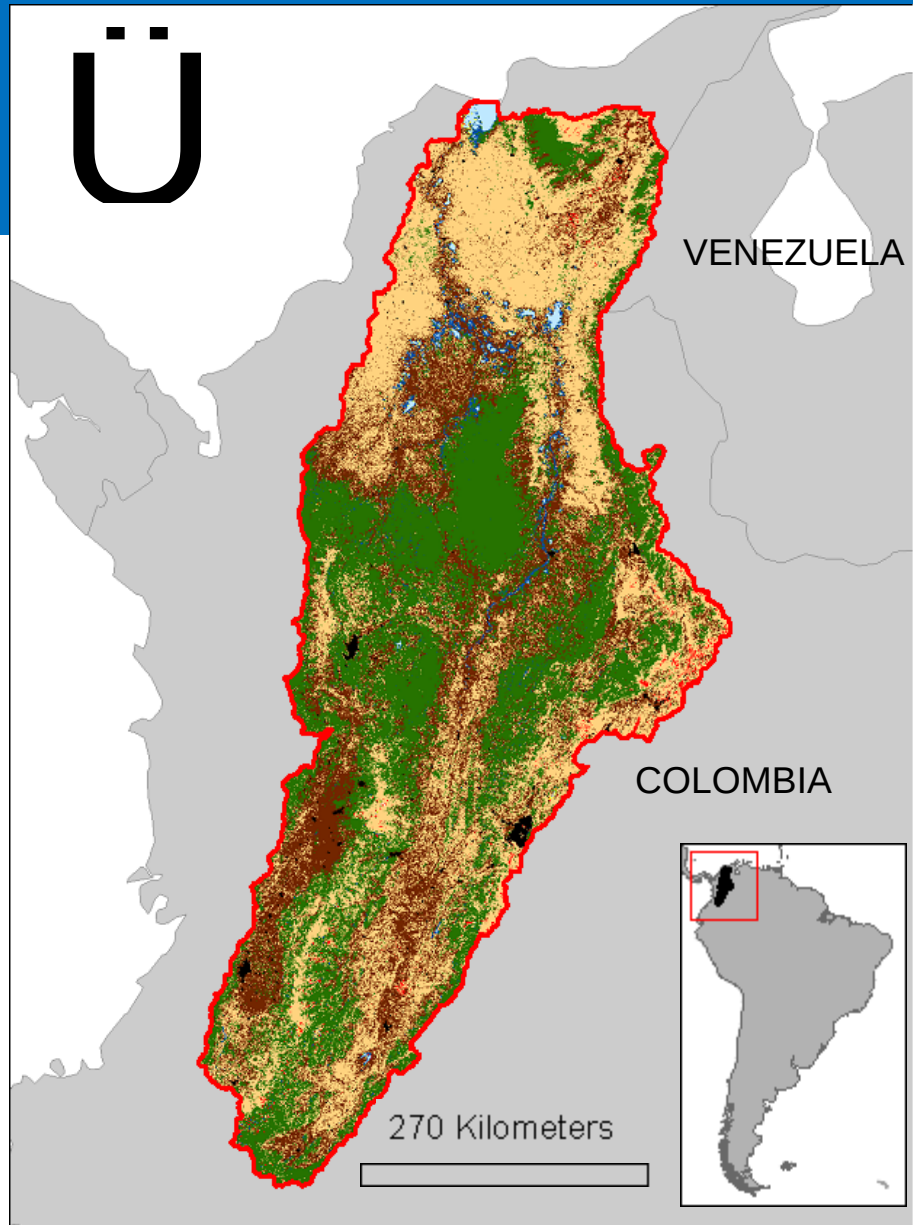
Satellite: Aqua and Terra

Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer)

Product: MCD12Q1

Spatial Resolution: 1 km

Temporal Resolution: annual



Land Cover

Rio Magdalena Watershed

Year: 2003

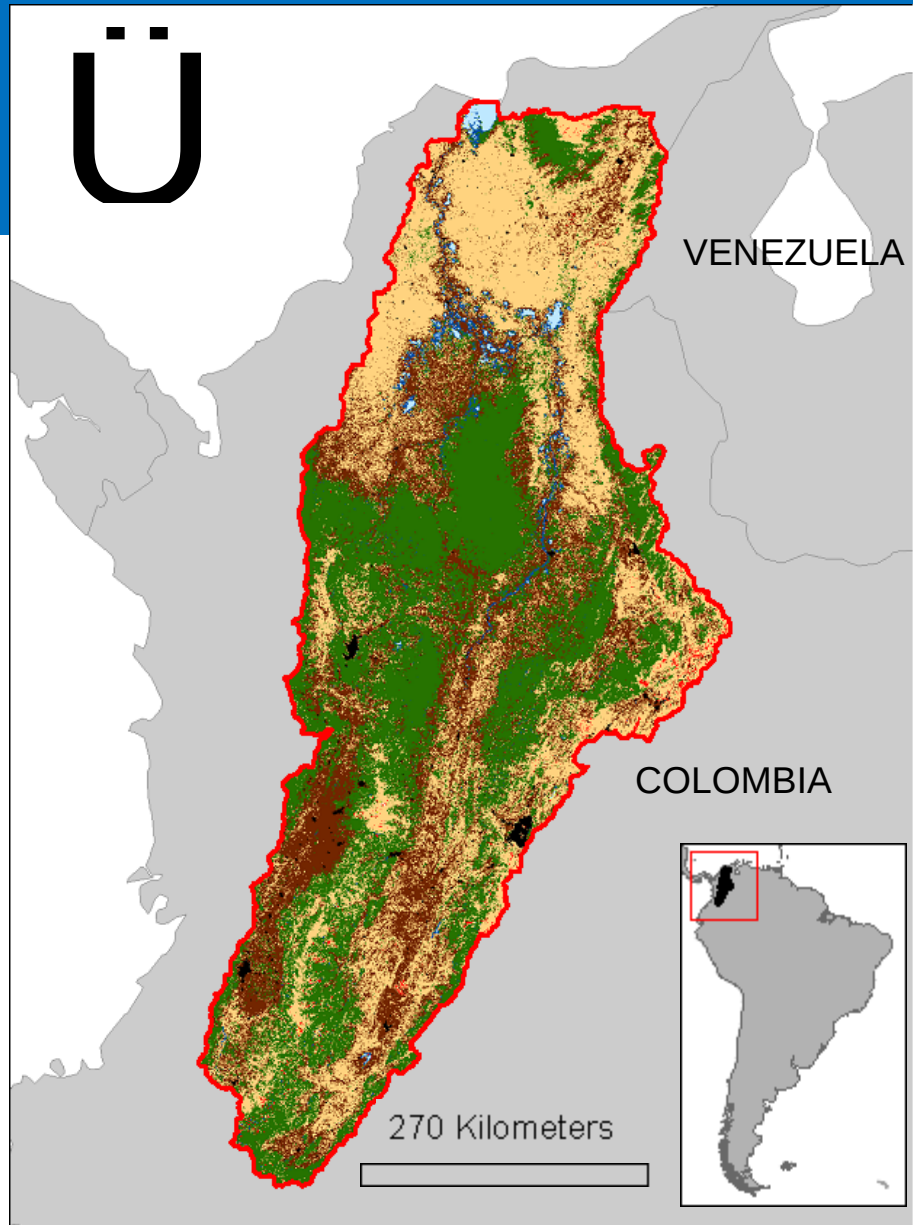
Satellite: Aqua and Terra

Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer)

Product: MCD12Q1

Spatial Resolution: 1 km

Temporal Resolution: annual



Land Cover

Rio Magdalena Watershed

Year: 2004

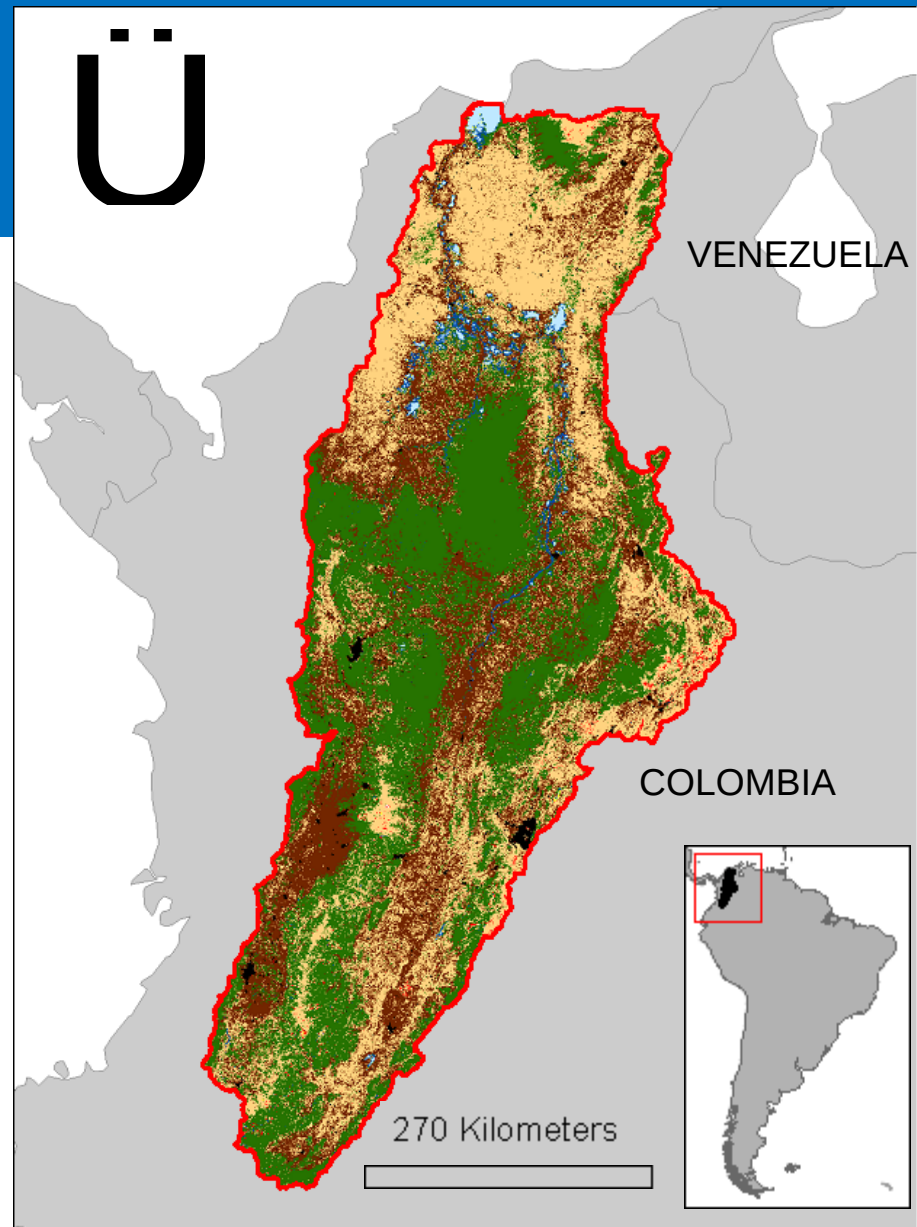
Satellite: Aqua and Terra

Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer)

Product: MCD12Q1

Spatial Resolution: 1 km

Temporal Resolution: annual



Land Cover

Rio Magdalena Watershed

Year: 2005

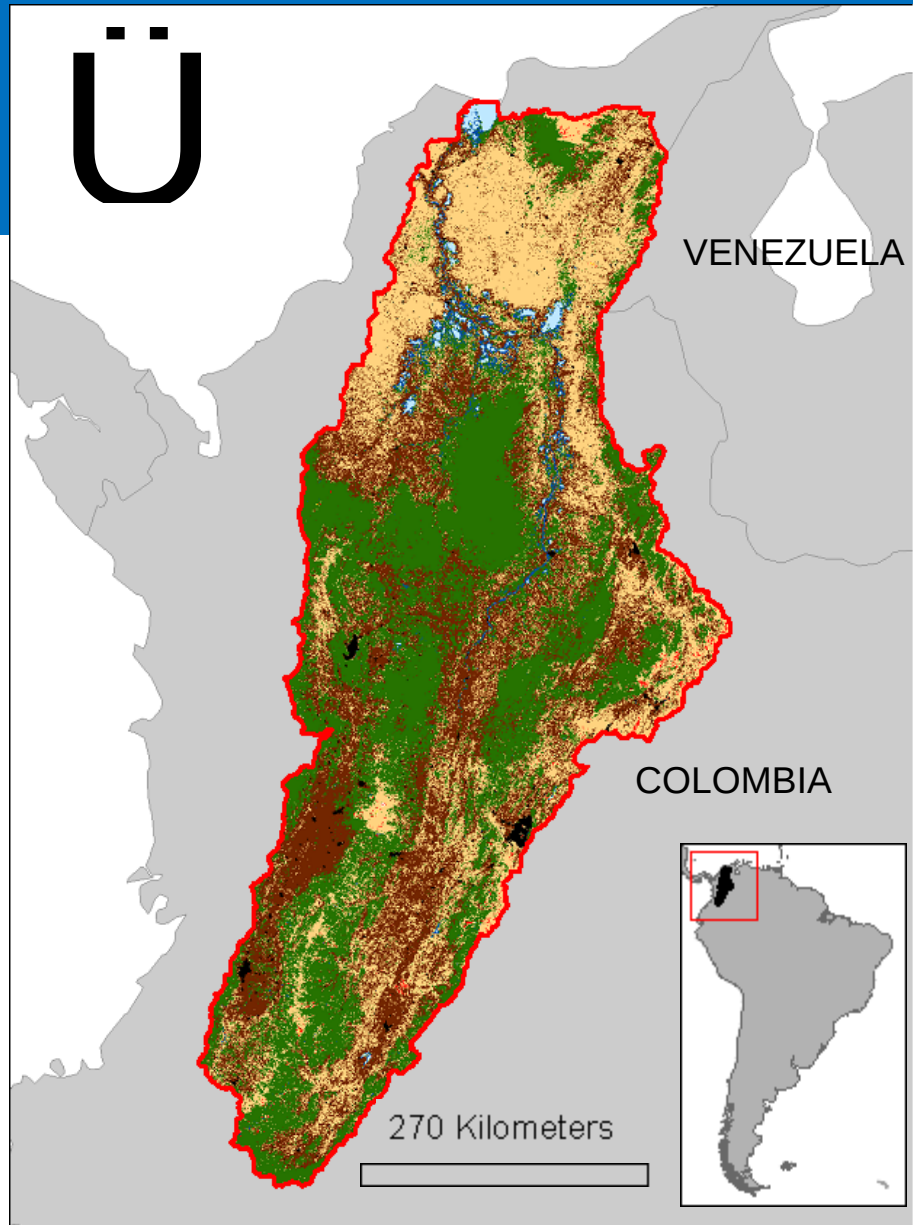
Satellite: Aqua and Terra

Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer)

Product: MCD12Q1

Spatial Resolution: 1 km

Temporal Resolution: annual



Land Cover

Rio Magdalena Watershed

Year: 2006

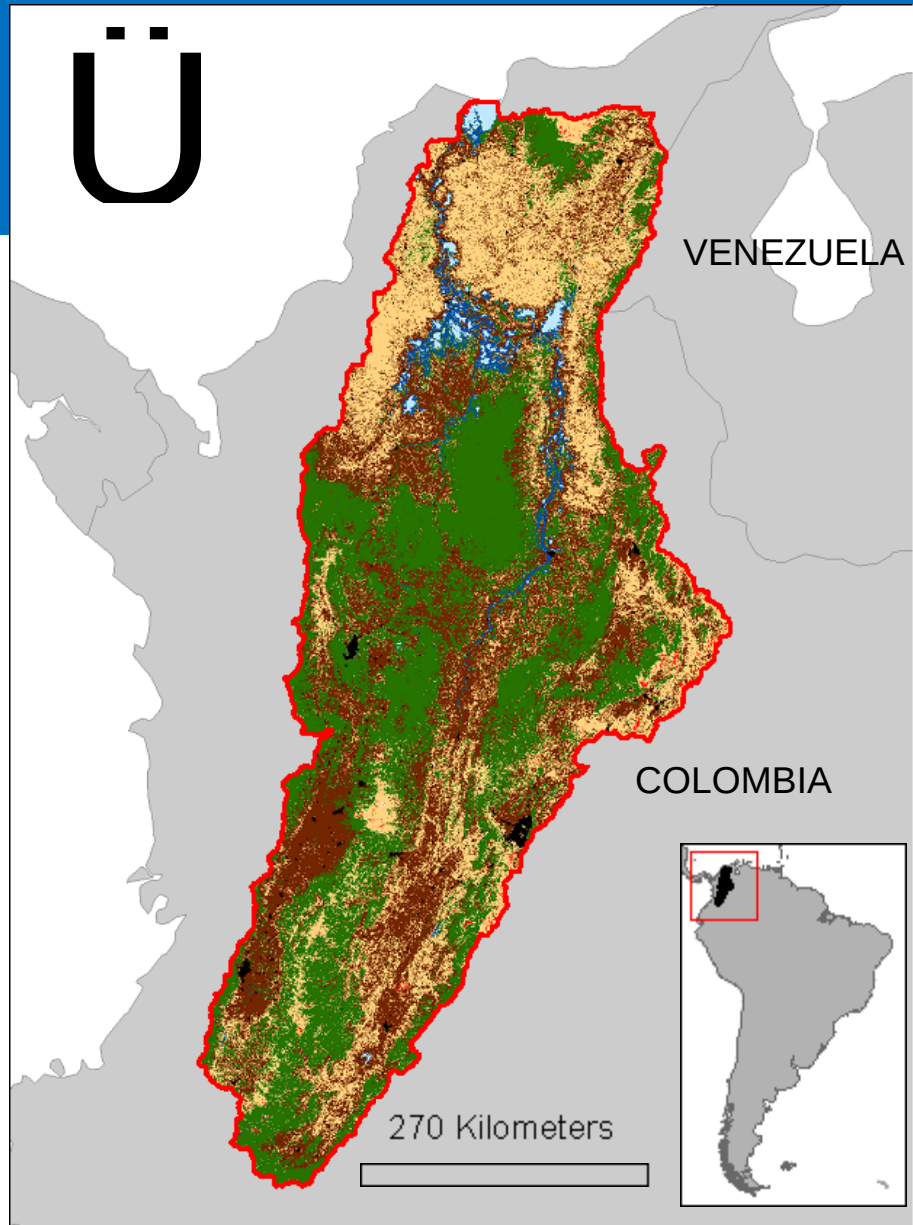
Satellite: Aqua and Terra

Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer)

Product: MCD12Q1

Spatial Resolution: 1 km

Temporal Resolution: annual



Land Cover

Rio Magdalena Watershed

Year: 2007

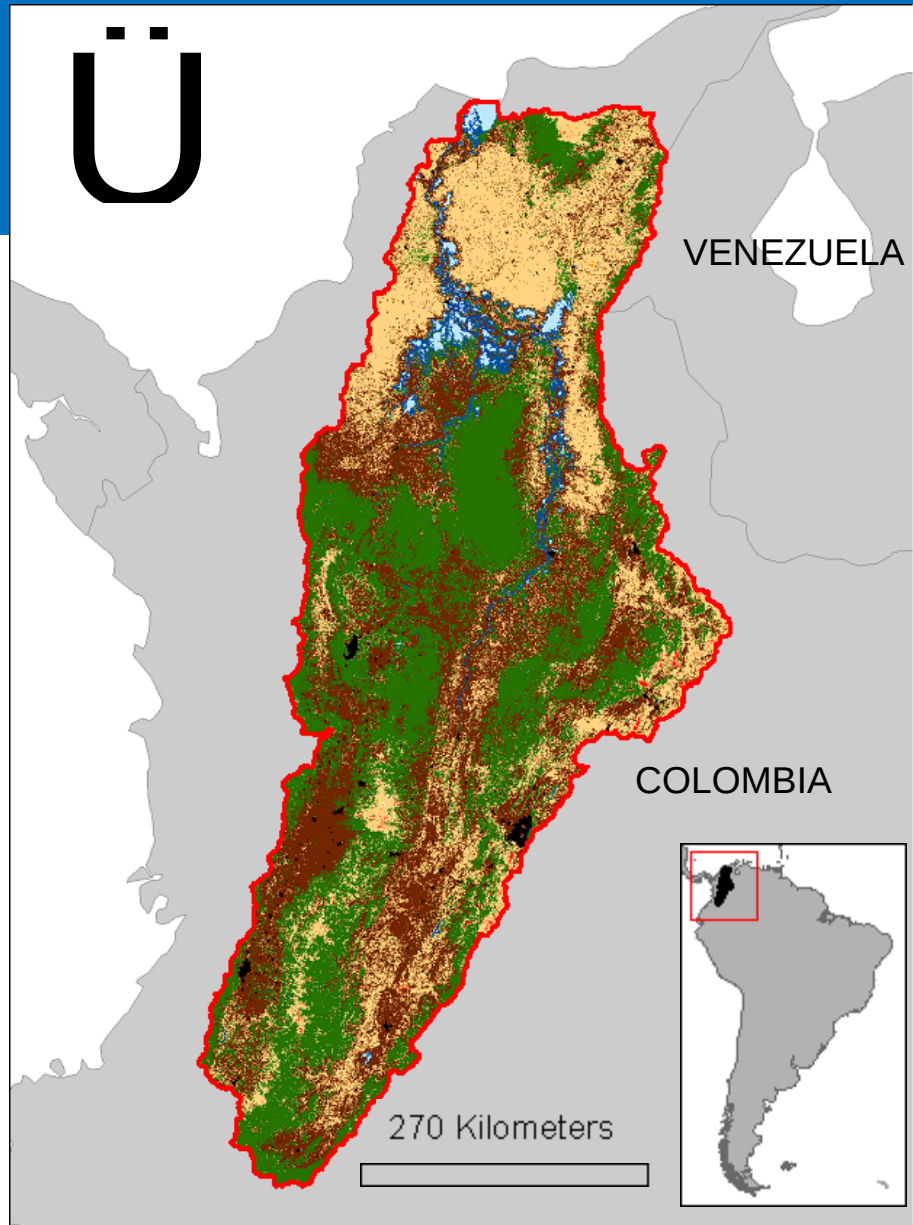
Satellite: Aqua and Terra

Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer)

Product: MCD12Q1

Spatial Resolution: 1 km

Temporal Resolution: annual



Land Cover

Rio Magdalena Watershed

Year: 2008

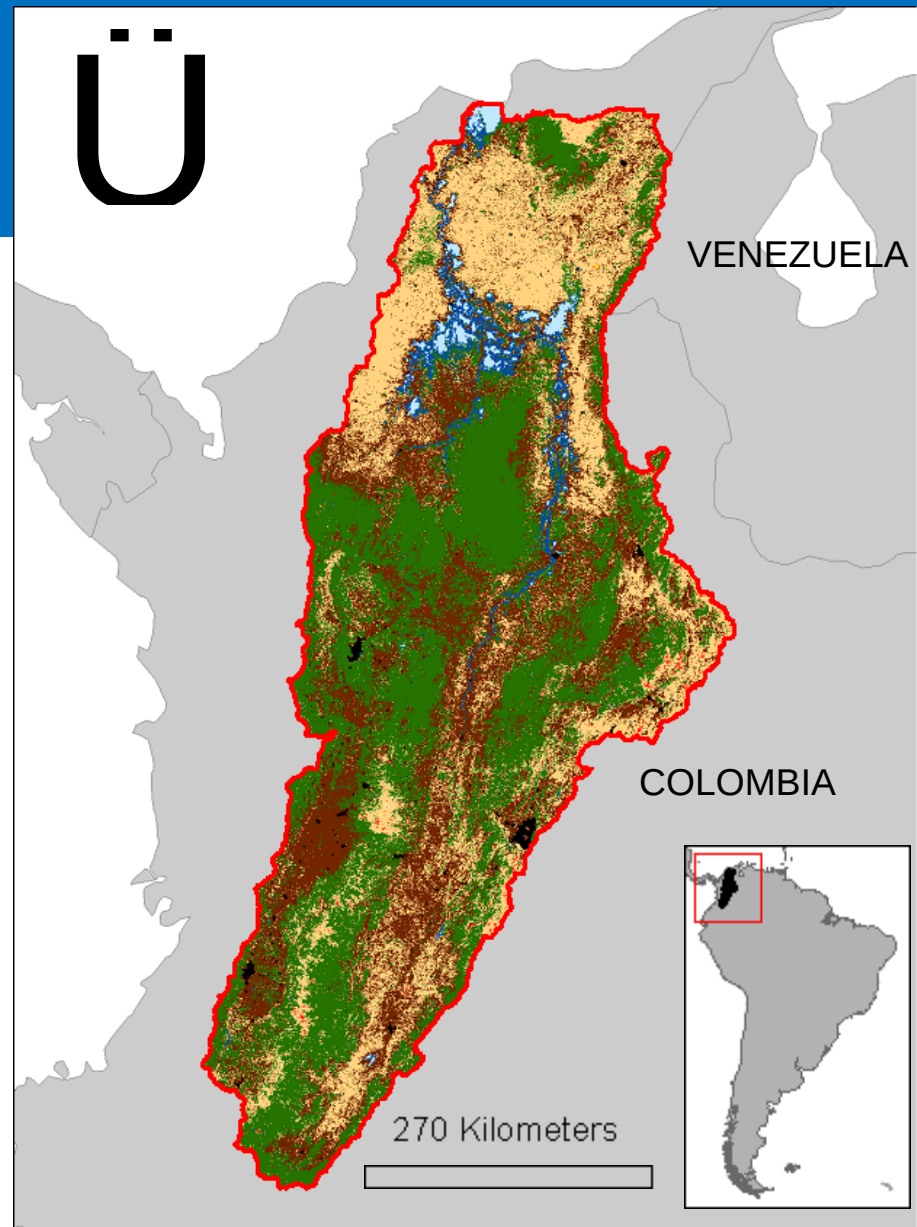
Satellite: Aqua and Terra

Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer)

Product: MCD12Q1

Spatial Resolution: 1 km

Temporal Resolution: annual



Land Cover

Rio Magdalena Watershed

Year: 2009

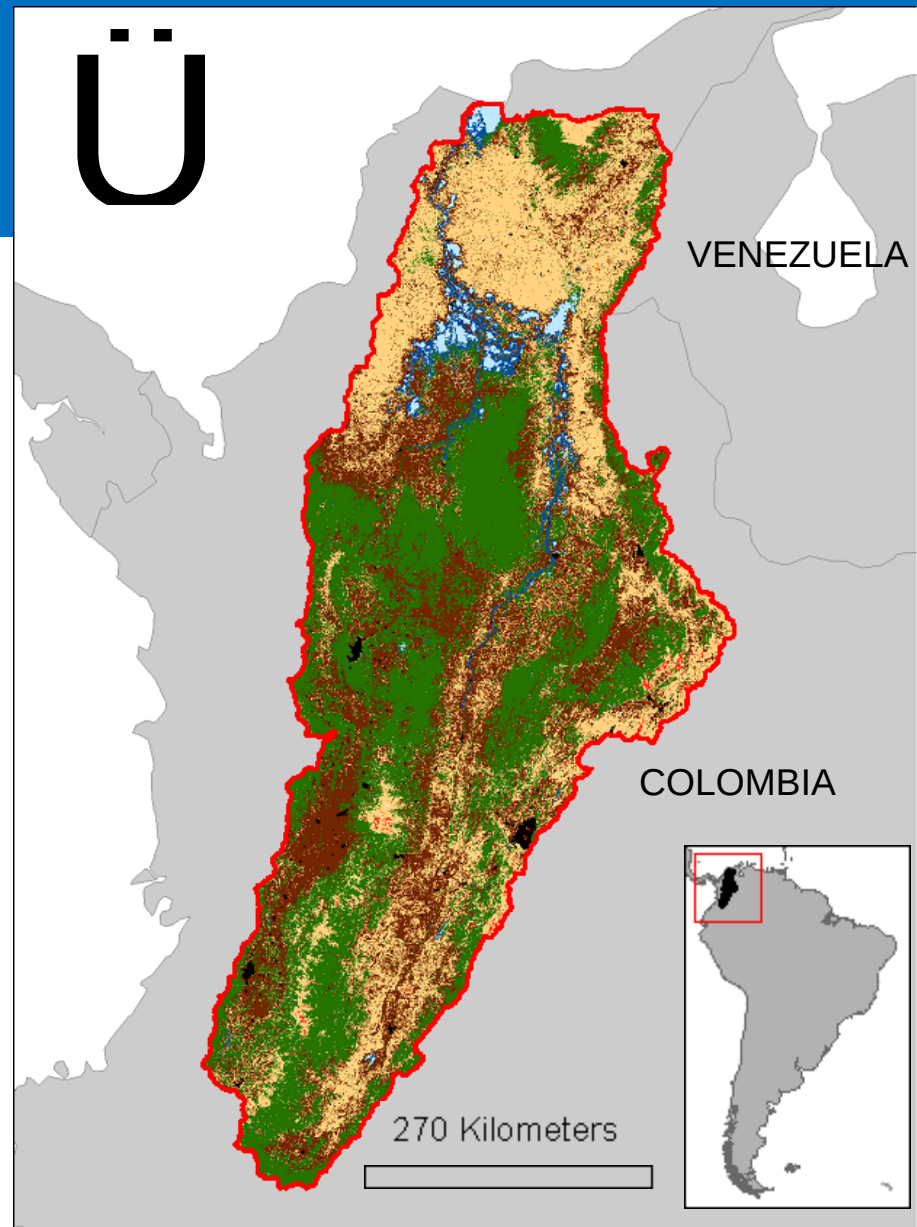
Satellite: Aqua and Terra

Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer)

Product: MCD12Q1

Spatial Resolution: 1 km

Temporal Resolution: annual



Land Cover

Rio Magdalena Watershed

Year: 2010

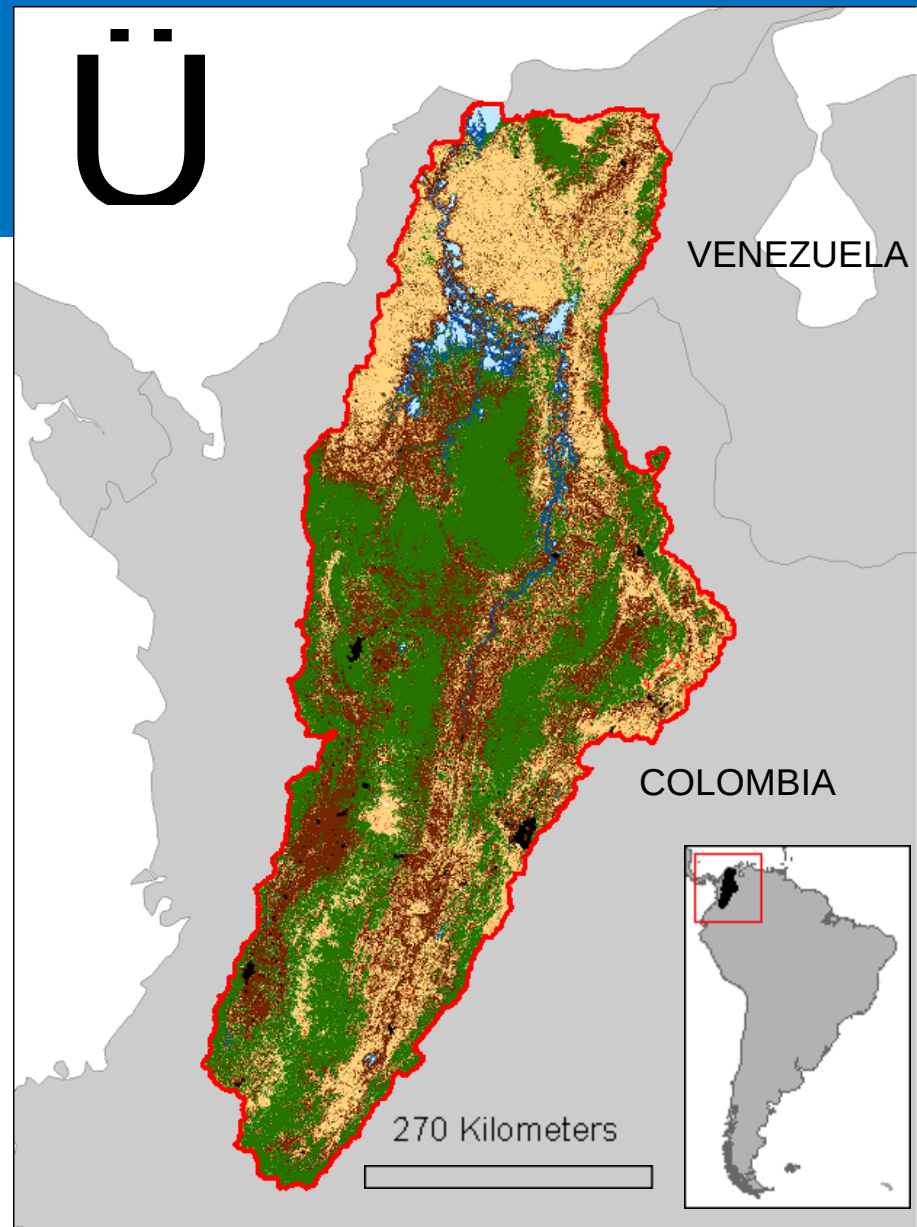
Satellite: Aqua and Terra

Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer)

Product: MCD12Q1

Spatial Resolution: 1 km

Temporal Resolution: annual



Land Cover

Rio Magdalena Watershed

Year: 2001

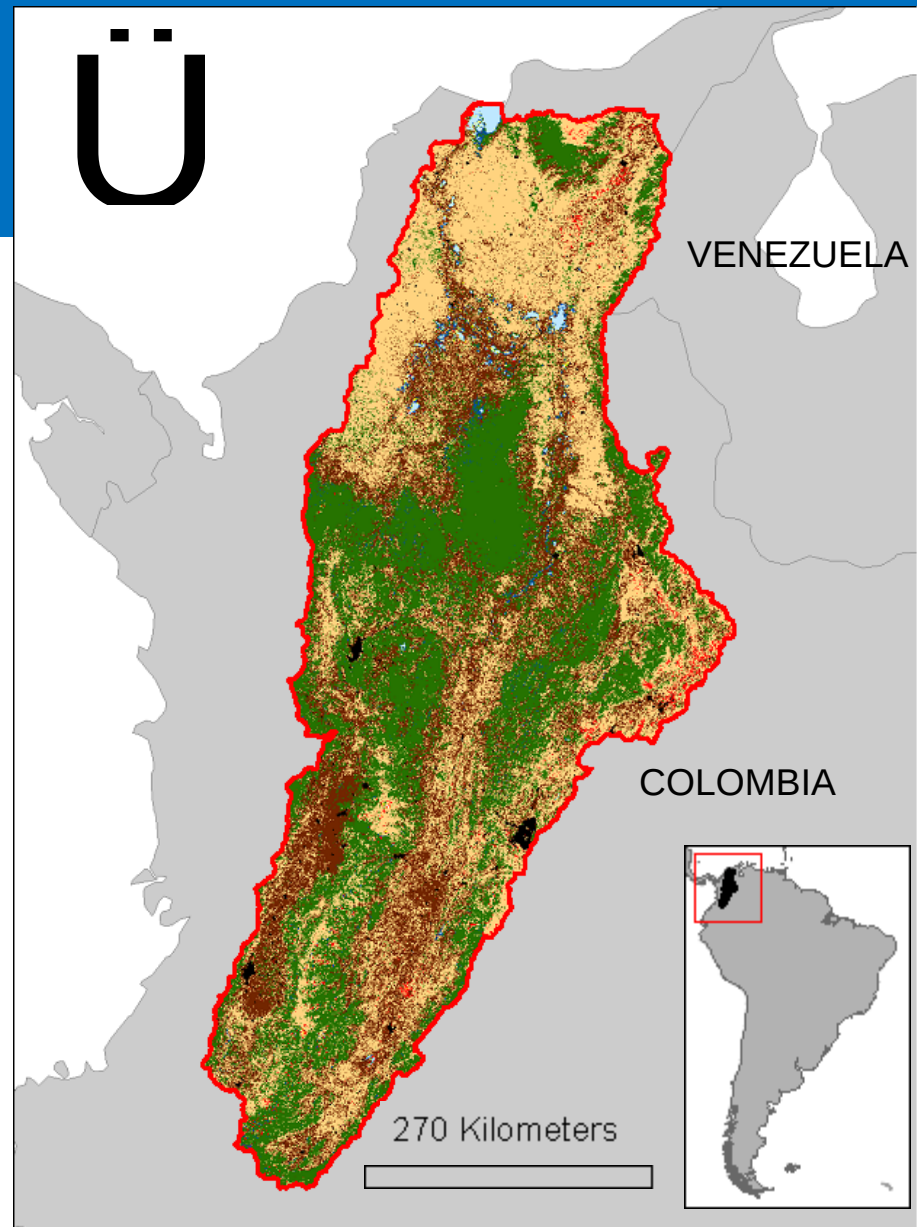
Satellite: Aqua and Terra

Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer)

Product: MCD12Q1

Spatial Resolution: 1 km

Temporal Resolution: annual

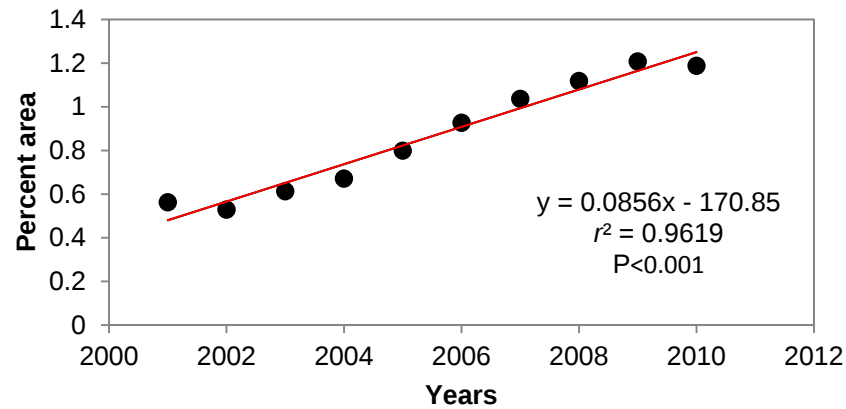


Change in Land Cover (2001-2010)

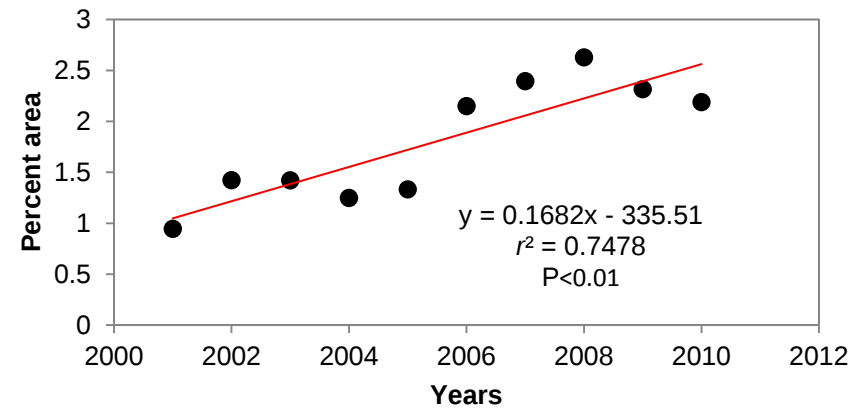
Land class	Percent	km ²	Relative to the total in 2010
Water	0.6	1961.5	0.2
Forest	4.8	14995.5	39.4
Shrublands	-0.8	-2376.5	0.4
Savannas and grasslands	-8.3	-26008.5	28.3
Wetlands	1.2	3905.8	2.2
Croplands	3.1	9727.3	28.8
Urban	0.0	-15.8	0.9
Snow and ice	0.0	60.3	0.0
Barren	-0.1	-288.0	0.0

Time series: Annual Land Cover (2001-2010)

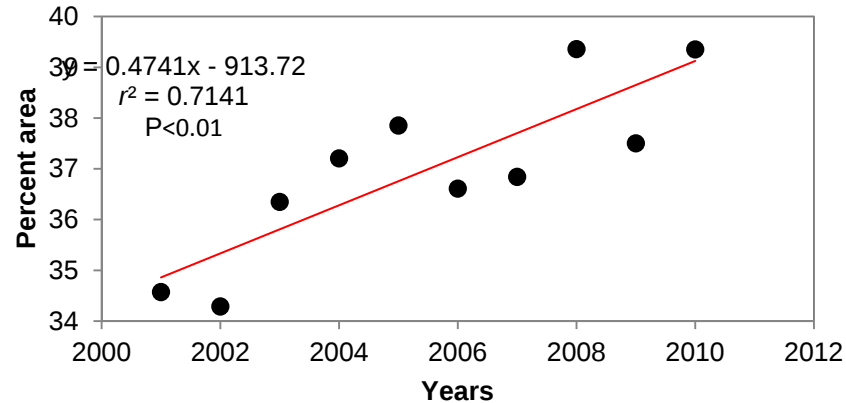
Water



Permanent wetlands

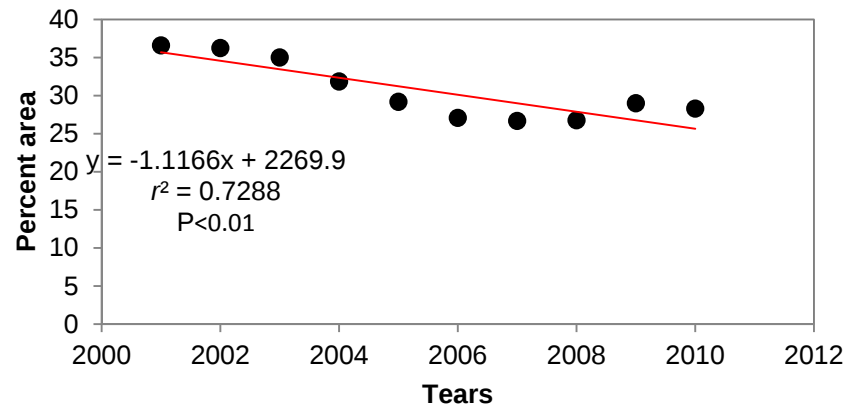


Forest

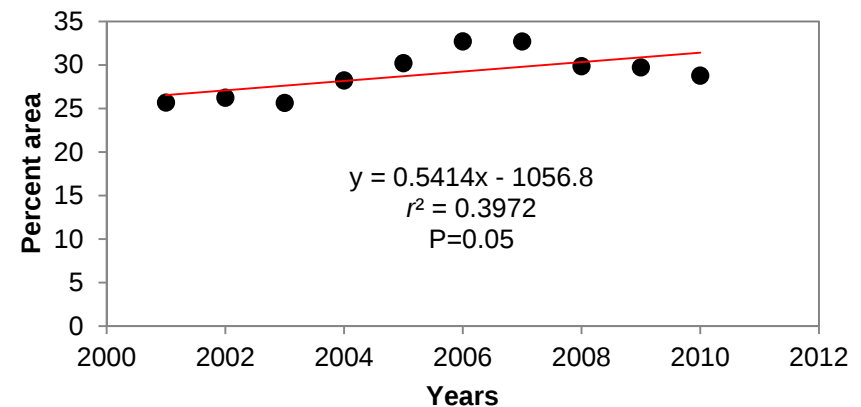


Time series: Annual Land Cover (2001-2010), cont.

Savannas and grasslands



Croplands



1. Relation between LC and coastal water reflectance

Refl.	Land Class	P	r^2	N
Bocas de Cenizas	Water	0.31	0.13	10
	Forest (all types)	0.35	0.11	10
	Shrublands	0.49	0.06	10
	Savannas and Grasslands	0.10	0.30	10
	Wetlands	0.32	0.12	10
	Croplands	0.10	0.31	10
	Urban and build-up	0.42	0.08	10
	Snow and Ice	0.79	0.01	10
	Barren or sparsely vegetated	0.84	0.01	10

2. Relation between LC and coastal water reflectance

Refl.	Land Class	P	r^2	N
Bahía de Cartagena	Water	0.21	0.19	10
	Forest (all types)	0.36	0.10	10
	Shrublands	0.28	0.14	10
	Savannas and Grasslands	0.04	0.43	10
	Wetlands	0.14	0.26	10
	Croplands	0.02	0.50	10
	Urban and build-up	0.33	0.12	10
	Snow and Ice	0.84	0.01	10
	Barren or sparsely vegetated	0.69	0.02	10

3. Relation between LC and coastal water reflectance

Refl.	Land Class	P	r^2	N
Bahía de Barbacoas	Water	0.04	0.42	10
	Forest (all types)	0.11	0.29	10
	Shrublands	0.11	0.29	10
	Savannas and Grasslands	0.03	0.48	10
	Wetlands	0.04	0.44	10
	Croplands	0.06	0.37	10
	Urban and build-up	0.09	0.31	10
	Snow and Ice	0.23	0.18	10
	Barren or sparsely vegetated	0.38	0.10	10

4. Relation between LC and coastal water reflectance

Refl.	Land Class	P	r^2	N
Islas del Rosario	Water	0.06	0.38	10
	Forest (all types)	0.01	0.56	10
	Shrublands	0.00	0.77	10
	Savannas and Grasslands	0.04	0.43	10
	Wetlands	0.07	0.36	10
	Croplands	0.17	0.22	10
	Urban and build-up	0.06	0.36	10
	Snow and Ice	0.15	0.24	10
	Barren or sparsely vegetated	0.00	0.81	10

Max J. Moreno Madriñán: max.j.moreno-madrinan@nasa.gov

